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LIST OF ACRONYMS AND ABBREVIATIONS

ACS	Assembly and command ship
AIP	Accident Investigation Plan
AST	Office of the Associate Administrator for Commercial Space Transportation
CDF	Charles Darwin Foundation
CDIAC	Carbon Dioxide Information Analysis Center
CDRS	Charles Darwin Research Station on Environmental Quality
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cm	Centimeter
CO	Carbon monoxide
CO_2	Carbon dioxide
COMSTAC	Commercial Space Transportation Advisory Committee
CUPA	Certified Unified Program Agencies
dB	Decibels
DM-SL	Block DM-Sea Launch is the upper stage of the Zenit-3SL launch vehicle
DOT	U.S. Department of Transportation
E	East
EA	Environmental Assessment
E_c	Expected casualty
EEZ	Exclusive Economic Zone
EIS	Environmental Impact Statement
EMPP	Environmental Monitoring and Protection Plan
E.O.	Executive Order
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right to Know Act
EST	Eastern Standard Time
FAA	Federal Aviation Administration
FAO	Food and Agriculture Organization
FONSI	Finding of No Significant Impact
ft	Feet
GEO	Geosynchronous earth orbit
GSO	Geosynchornous orbit
H_2	Hydrogen
H_2O	Water
HAT	High altitude tropical
HF	High Frequency
IIP	Instantaneous Impact Point
ILL	Impact Limit Lines
ILV	Zenit-3SL integrated launch vehicle
in	Inch
IUCN	International Union for Conservation of Nature and Natural Resources
kg	Kilogram
km	Kilometer
LEO	Low earth orbit
lb	Pound
LOL	Launch operator license
LOX	Liquid oxygen
LP	Launch platform
m	Meters
MARPOL	International Convention for the Prevention of Pollution from Ships
MEO	Medium earth orbit
mi	Mile
mm	Millimeter
MMH	Monomethylhydrazine
mph	Miles per hour
m/s	Meters per second
N	North
N_2	Nitrogen
N/A	Not applicable
N_2O_4	Nitrogen tetroxide
NEPA	National Environmental Policy Act
NIMA	National Imagery and Mapping Agency
NMFS	National Marine Fisheries Service
NO_X	Nitrogen oxides
O_3	Ozone molecule
OMB	Office of Management and Budget
OSHA	Occupational Safety and Health Administration
pH	Measure of acidity and/or alkalinity
RP-1	Kerosene fuel
S	South
sec	Second
SLLP	Sea Launch Limited Partnership
SPREP	South Pacific Regional Environmental Programme

SCAQMD	South Coast Air Quality Management District
UDMH	Unsymmetrical dimethylhydrazine
UN	United Nations
UNESCO	United Nations Educational, Scientific, and Cultural Organization
U.S.C.	United States Code
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service
USSC	U.S. Space Command
W	West
WCMC	World Conservation Monitoring Center
WR	Written Reevaluation

EXECUTIVE SUMMARY

ES. 1 INTRODUCTION

This Draft Environmental Assessment (EA) evaluates the potential environmental effects of the license applicant's proposed action wherein the Federal Aviation Administration (FAA) Associate Administrator for Commercial Space Transportation (AST) would issue an launch operator license (LOL) or launch-specific licenses to Sea Launch Limited Partnership (SLLP). If issued, the LOL would allow SLLP to conduct up to eight commercial launches per year for five years without obtaining a separate license for each launch as long as there is no change in the launch parameters or in the anticipated environmental impacts. These launches would all be equatorial and would use azimuths between 82.6° and 97.4°, inclusive, originating from the SLLP Launch Platform (LP) at 0° latitude and 154° West (W) longitude, which is 425 kilometers (km) (266 miles (mi)) from Kiritimati (Christmas Island) in the Kiribati Island Group in the Pacific Ocean. This EA also addresses the proposed issuance of a launch-specific license for the launch of a Galaxy IIIC payload as well as other launch-specific licenses for launches within the proposed azimuth range and other specified launch parameters should the LOL not be issued or be delayed.

ES. 2 BACKGROUND

The SLLP project is an international commercial space launch project owned and operated jointly by Boeing Commercial Space Company of the United States, RSC Energia of Russia, KB Yuzhonoye and PO Yuzhmash of Ukraine, and Moss Maritime a.s. of Norway. The project's main assets are a seagoing mobile launch platform (LP), assembly and command ship (ACS), Home Port facilities in Long Beach, California , and the Zenit-3SL. The FAA issued a Final Environmental Assessment for the Sea Launch Project on February 11, 1999 (February 11, 1999 EA). This EA addressed the environmental impacts associated with SLLP's proposal to launch one demonstration payload and one satellite during the first year of operation and up to a maximum of six launches per year, using an azimuth of 88.67°, originating from the LP at 0° latitude and 154° W longitude. SLLP has conducted seven launches to date under seven individual launch licenses.

ES. 3 PURPOSE AND NEED FOR THE LICENSE APPLICANT'S PROPOSED ACTION

Access to space has become increasingly important for the deployment of satellites used for scientific research, communications, and multimodal transport navigation systems. Given the infrastructure and technology development costs associated with launching and deploying satellites, the Federal Government has been responsible for the majority of launches. However, with the increasing demand for access to space, especially for communications satellites, commercial launch companies have begun to offer launch services to meet this demand.

The purpose of the license applicant's proposed action as defined in 49 U.S.C. Subtitle IX – Commercial Space Transportation, ch. 701, Commercial Space Launch Activities, 49 U.S.C. §§ 70101-70121 is to:

- Promote economic growth and entrepreneurial activity through use of the space environment for peaceful purposes;
- Encourage the U.S. private sector to provide launch vehicles, reentry vehicles, and associated services by simplifying and expediting the issuance of licenses;

- Provide FAA oversight and coordination of licensed launches and to protect the public health and safety, safety of property, and national security and foreign policy interests of the U.S.; and
- Facilitate the strengthening and expansion of the U.S. space transportation infrastructure.

The need for the license applicant's proposed action is to streamline the FAA's licensing process, thereby enabling a qualified, U.S. launch provider the flexibility (in terms of both cost and schedule) to capture a share of the projected geosynchronous orbit (GSO) satellite launch market. The proposed LOL would cover multiple launches using the same infrastructure at the same launch location through a range of launch azimuths without the need to re-evaluate license applications for individual launches unless conditions or operations change or an unforeseen environmental impact is discovered. The proposed LOL would allow SLLP to conduct up to eight launches per year for five years, for a maximum of 40 launches. The proposed LOL would allow SLLP to launch on exact equatorial azimuths (e.g., 90^{o}), which are optimal for GSO launches in terms of fuel efficiency, payload weight, and satellite life span.

ES. 4 THE LICENSE APPLICANT'S PROPOSED ACTION DEFINED

The FAA is evaluating the license applicant's proposed action, which would specifically authorize SLLP to:

- Conduct up to eight launches per year over a five-year period, for a maximum of 40 launches;
- Use a launch site at 0° latitude and 154°W longitude;
- Launch along a range of launch azimuths from 82.6° to 97.4°, inclusive;
- Use a Zenit-3SL launch vehicle; and
- Transport specified classes of payloads.

The FAA is also evaluating the possibility of issuing a launch-specific license to SLLP for the launch of Galaxy IIIC, as well as other potential launch-specific licenses (not to exceed eight per year) as necessary should the proposed LOL not be issued or be delayed. The proposed launch-specific licenses would authorize the SLLP to conduct specific launches:

- From a launch site at 0^{o} latitude and 154^{o}W longitude;
- On a launch along an azimuth of 90.00^{o};
- Using a Zenit-3SL launch vehicle; and
- Transporting specified classes of payloads.

ES.4.1 ALTERNATIVES INCLUDING NO ACTION AND THE ALTERNATIVES EVALUATION PROCESS

The FAA considered six alternatives in addition to the license applicant's proposed action. These alternatives included issuing the LOL with various changes in the launch parameters:

- Alternative with Up to 12 Launches Per Year. This alternative evaluates increasing the annual number of launches up to a maximum of 12 per year;
- Alternative with a Range of Azimuths Between 70^{o} and 110^{o}. This alternative considers a wider range of azimuths, those from 70^{o} to 110^{o}, inclusive, identified as feasible for GSO launches;
- Alternative with Avoidance of National Parks and National Reserves. This alternative would involve launching along a range of azimuths between 82.6^{o} and 97.4^{o} but would avoid specific azimuths within this range that would overfly any National Park or National Reserve;
- Alternative with Avoidance of the Oceanic Islands. This alternative would involve launching along a range of azimuths between 82.6^{o} and 97.4^{o} but would avoid any azimuth that would overfly any of the Oceanic Islands; and
- Alternative with Avoidance of the Galapagos Islands. This alternative would involve launching along a range of azimuths between 82.6^{o} and 97.4^{o} but would avoid any azimuths that overfly the Galapagos Islands Group; and
- No Action Alternative.

The FAA completed a thorough and objective review of reasonable alternatives to the license applicant's proposed action. The Council on Environmental Quality (CEQ) regulations require that the agency look at "reasonable" alternatives to a proposed action. With that standard in mind, the FAA did not evaluate in detail those alternatives that showed no possibility of meeting the purpose and need of the license applicant's proposed action, as described previously. The following criteria were used to determine whether alternatives were reasonable to evaluate in detail in the EA:

- Promote economic growth and entrepreneurial activity through use of the space environment for peaceful purposes;
- Encourage U.S. private sector to provide launch vehicles, reentry vehicles, and associated services by simplifying and expediting the issuance of licenses;
- Provide FAA oversight and coordination of licensed launches and to protect the public health and safety, safety of property, and national security and foreign policy interests of the US; and
- Facilitate the strengthening and expansion of the U.S. space transportation infrastructure.

Based on the evaluation of alternatives using the above screening criteria and the requirements of the National Environmental Policy Act (NEPA), the following alternatives were evaluated in detail in the EA:

- License Applicant's Proposed Action,
- Alternative with Avoidance of the Oceanic Islands,
- Alternative with Avoidance of the Galapagos Islands, and
- No Action Alternative.

ES. 5 THE AFFECTED ENVIRONMENT

The launched vehicle would proceed east on a single trajectory, on an azimuth between 82.6° and 97.4°, over the equatorial Pacific Ocean and South America. The area potentially affected by the proposed launches includes all land and water between 7.4° N and 7.4° S of the equator and between the launch location and the eastern coast of South America. Beyond this point the payload would be orbital and no further environmental effects on land or water are expected to occur (see Figure ES-1). This area encompasses approximately 9 million km^2 (3.5 million mi^2) of the equatorial Pacific Ocean and 5 million km^2 (1.9 million mi^2) of South America. The vast majority of the marine area is deep, open portions of the Pacific Ocean, although the proposed range of flightpaths include overflight of the Galapagos Islands, Cocos Island, and Malpelo Island. Further east, the area of the South American flyover encompasses several ecosystems, including Pacific coastal lowlands, the Andean mountain range, and much of the Amazon River basin.

ES.5.1 OCEANIC ISLANDS

The Oceanic Islands within the overflight zone of the proposed project include sensitive ecosystems of international importance. Cocos Island, governed by Costa Rica, is located approximately 500 km (312 mi) west of the Pacific coast of Costa Rica, and is approximately 2 km (1.2 mi) long and 1 km (0.6 mi) wide. A protected National Park, Cocos Island was added to the United Nations Educational, Scientific, and Cultural Organization (UNESCO) World Heritage List in 1997 and was subsequently designated a Wetland of International Importance (RAMSAR, 1998). Malpelo Island, governed by Colombia, lies approximately 450 km (281 mi) west of Colombia in the equatorial Pacific Ocean and is approximately 2.2 km (1.4 mi) long and 0.8 km (0.5 mi) wide.

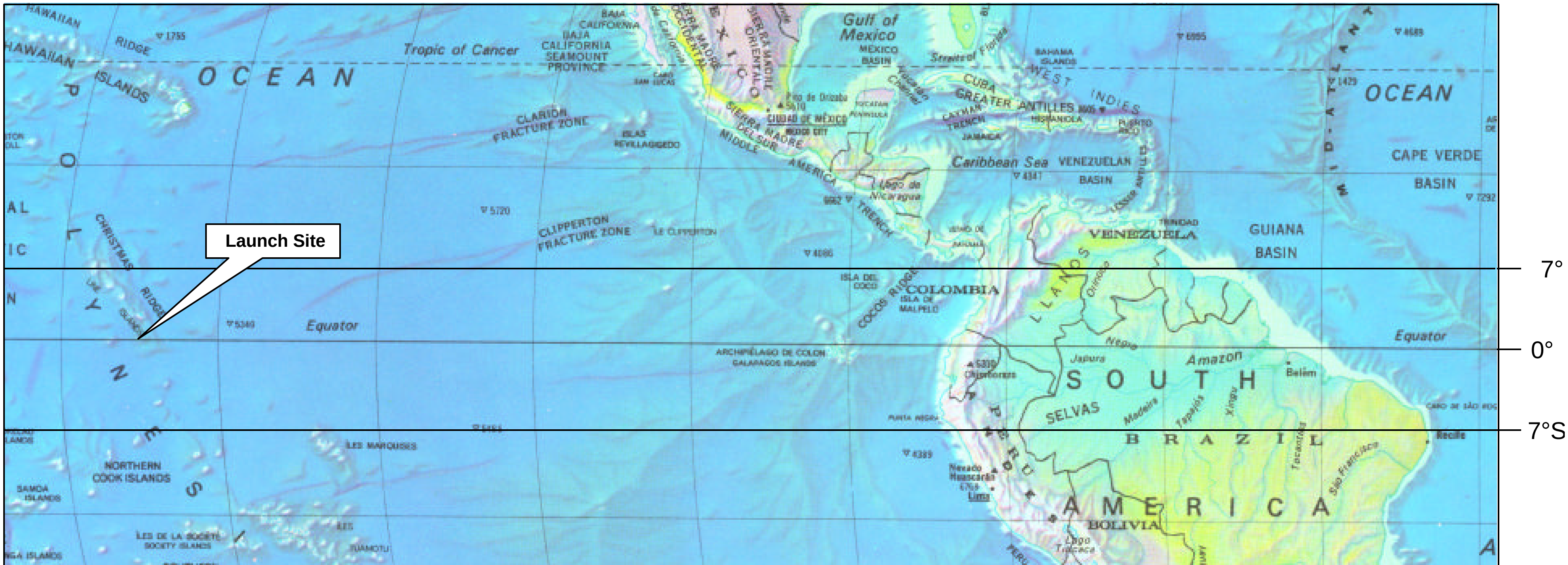
ES.5.2 GALAPAGOS ISLANDS

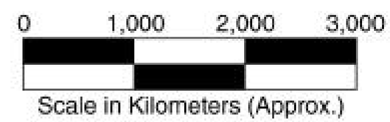
The Galapagos Islands, a province of the Republic of Ecuador, consist of 120 islands, rocks, and islets with a total land area of about 8,000 km^2 (3090 mi^2) in the eastern Pacific Ocean, 1,000 km (625 mi) west of the mainland. In 1959 Ecuador designated 97 percent of the land area of the Galapagos as a national park, and in 1986 established the Galapagos Marine Resources Reserve to protect the waters around the archipelago. The Galapagos Islands have also been recognized internationally as a Man and Biosphere Reserve and as a World Heritage Site by UNESCO. Ecuador manages the islands through the Galapagos National Park Service.

ES.5.3 SOUTH AND CENTRAL AMERICA

The portion of South America and Central America within the affected environment includes all of Ecuador, Surinam, and French Guiana, and portions of Colombia, Venezuela, Peru, Brazil, Guyana, and Panama. This region generally consists of three geographical areas traversing from west to east: the pacific coastal lowlands, the Andean mountain range (including high elevation valleys and plateaus), and the eastern lowlands (including much of the Amazon River basin).

Figure ES-1
Affected Environment - From Launch Site to Eastern South America (7° north to 7° south)





Source: Rand McNally Atlas of the World.

ES. 6 ENVIRONMENTAL CONSEQUENCES

ES.6.1 LICENSE APPLICANT'S PROPOSED ACTION

ES.6.1.1 Successful Flight

Stage I and II flight would occur over open ocean areas. In this respect, the environmental effects associated with Stage I and II components and their operation during a successful flight along any azimuth in this license applicant's proposed action would be the same as those evaluated in Sections 4.3.2 and 4.5.5 of the February 11, 1999 EA. These effects include:

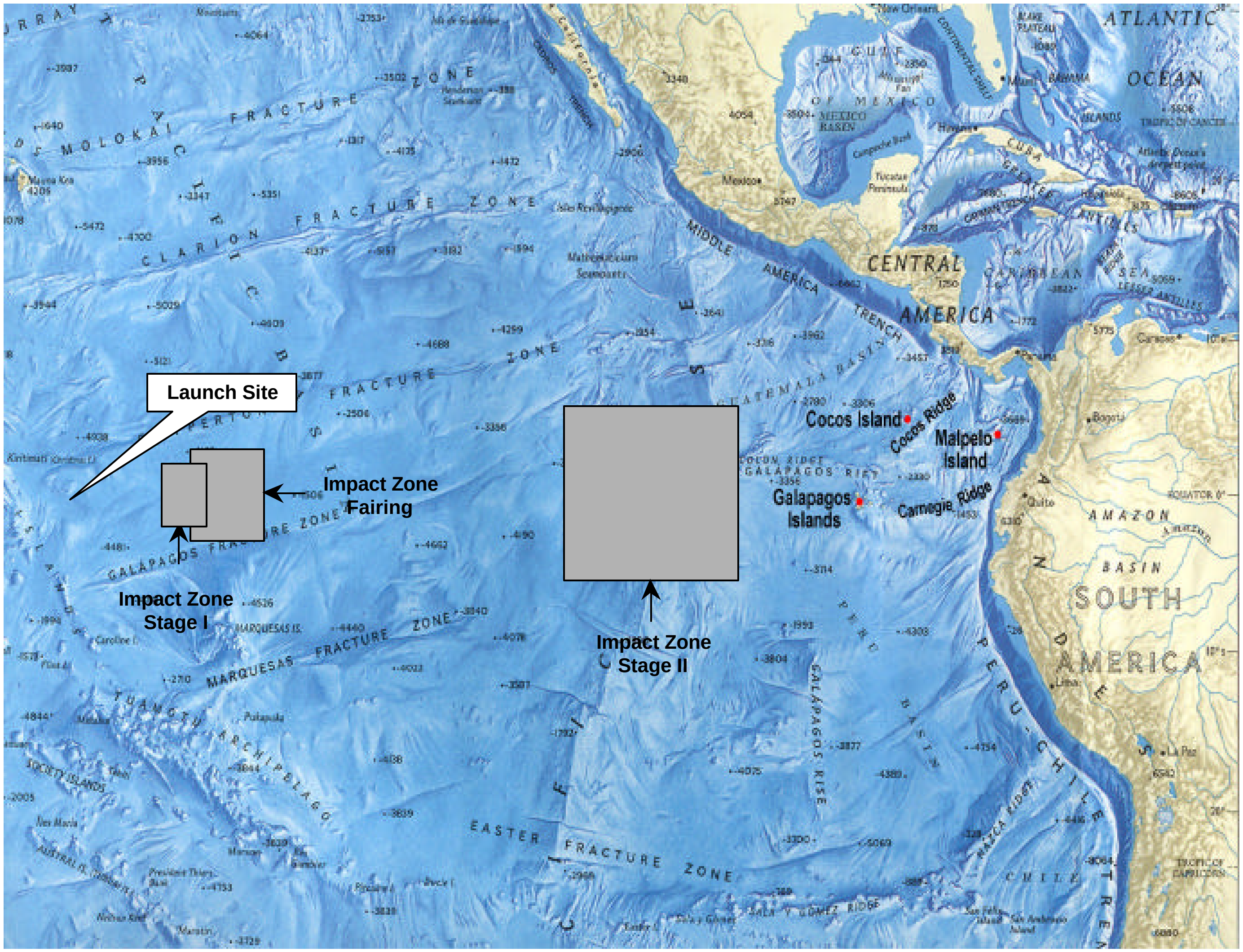
- Spent stages, fairing, and sleeve adapter (i.e., connection between Stage II and the Upper Stage) deposition in the ocean;
- Combustion emissions released to the atmosphere;
- Residual propellants released from spent stages to the atmosphere and ocean; and
- Risk of spent stages, fairing or sleeve adapter falling on a marine organism, ship, fishing vessel, or aircraft.

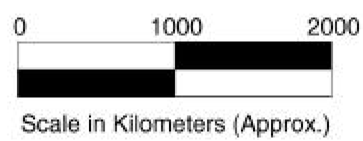
Geology, Oceanography, and Atmospheric Processes

As shown in Figure ES-2, Stage I and fairing impact zones overlap slightly, and jointly form a rectangle of approximately 480 km (north to south) by 600 km (east to west) (300 by 375 mi). These impact zones are located in water 2,000 to 4,000 meters (m) (1.2 to 2.5 mi) deep. The Stage II impact zone is approximately 1,270 km (790 mi) by 1,320 km (820 miles). The water depth in this area is approximately 3,900 m (2.4 mi). The deposition of spent stages and the fairing in these areas would be inconsequential relative to natural geologic processes in the region.

The open ocean environment within the proposed range of azimuths is largely uniform in terms of oceanic and atmospheric processes, with biological characteristics (e.g., plankton biomass) primarily varying with nutrient and mineral levels (Barber, et al., 1996). The spent stages and fairing pieces from any launch within the proposed range of azimuths would fall into undifferentiated deep, open waters of the tropical equatorial Pacific Ocean, far away from any Oceanic Islands or continental landmass (see Tables ES-1 and ES-2).

Figure ES-2
Impact Zones for Stage I, Stage II, and Fairing





Source: National Geographic Society.
Mercator Projection,

Note: Depths are in meters.

TABLE ES-1. IMPACT ZONES FOR SPENT STAGES AND FAIRING

Flight Element		Open Ocean Impact Zone		
Component	**Mass in kilogram (kg) pounds (lbs)**	**Latitude**	**Longitude**	**Area in square kilometer (km^2) square mile (mi^2)**
Stage I	36,500 (80,300)	2°South (S) to 2°North (N)	147.7°W to 145.5°W	107,000 (41,800)
Fairing halves*	2,400 (both) (5,280)	2.2°S to 2.2°N	146.6°W to 142.2°W	240,000 (93,800)
Stage II and sleeve adapter	11,515 (25,333)	6°S to 6°N	116.6°W to 105.1°W	1,680,000 (660,000)

* Data shown are for the potential 5-m (16.5 foot (ft)) fairing

TABLE ES-2. SHORTEST EXPECTED DISTANCES BETWEEN LANDMASSES AND ZENIT-3SL INTEGRATED LAUNCH VEHICLE (ILV) STAGE IMPACT ZONES

Landmass (Country)	Distance Between Landmass and Stage I Impact Zone (km (miles))	Distance Between Landmass and Fairing Impact Zone (km (miles))	Distance Between Landmass and Stage II Impact Zone (km (miles))
Kiritimati Island (Kiribati)	1,073 (667)	1,196 (743)	4,526 (2,813)
Malden Island (Kiribati)	841 (523)	954 (593)	4,255 (2,644)
Hatutu Island (France)	1,027 (638)	660 (410)	2,651 (1,648)
Clipperton Island (France)	4,108 (2,553)	3,748 (2,329)	476 (296)
Cocos Island (Costa Rica)	6,487 (4,032)	6,120 (3,804)	1,994 (1,239)
Galapagos Islands (Ecuador)	5,971 (3,711)	5,605 (3,483)	1,483 (922)
Malpelo (Colombia)	7,091 (4,407)	6,724 (4,179)	2,649 (1,646)

Given the expanse of the open ocean area within each impact zone, the environmental effect of stage and fairing deposition is minimal. For any individual launch, only 0.00003 percent, 0.000003 percent, and 0.000001 percent of the impact zone area would be affected by the Stage I, fairing, and Stage II depositions, respectively.

Residual propellants would be released as spent ILV components fall into the ocean. Residual LOX would dissipate immediately upon release. Residual kerosene would be dispersed into a mist during descent, and all but the largest droplets would evaporate within a few minutes. The environment would recover from the effects of the residual propellants and return to its natural condition within a few days.

Impacts on Biological Communities and Commercial Activities

Potential effects of successful launches on biological communities and commercial activities are limited to noise effects associated with the launch, and spent stages and fairings falling on a marine organism, ship, fishing vessel, or aircraft. Steady noise from pre- and post-launch operations (e.g., from ship engines) may reach 70 decibels (dB). Research indicates this level of noise would not have a detrimental affect on animals. Above the surface, launch noise could reach 150 dB at 378 m (1240 ft) which corresponds to 75 dB at the same distance below the surface.

There is a remote possibility that spent stages or the fairing may fall on a marine organism, ship or fishing vessel, or aircraft. As a mitigation measure, SLLP gives advance notice for each launch to the FAA (Central Altitude Reservation Function), the U.S. Coast Guard (USCG; 14th District), the National Imagery and Mapping Agency (NIMA), and the U.S. Space Command (USSC). To coordinate air, marine, and space traffic, these organizations issue necessary information, including notices, through well-established channels. For vessels without receiving equipment (expected to be limited to those operating out of Kiribati ports), standard notices are delivered by fax to Kiribati government authorities and regional fishing fleet and tour operators for distribution and posting.

ES.6.1.2 Possible Mission Failures

The FAA identified several failure scenarios based on previous experience with launches. A failed mission can occur at the LP, during Stage I or Stage II flight, or during Upper Stage flight. In most cases, a failure would result from a detected deviation between the programmed flight path parameter (e.g., pitch, yaw, roll) and the actual flight parameters as monitored by ILV sensors. If flight deviations exceed established limits, the thrust termination system would terminate the flight. A thrust termination system is a type of flight safety system. Flight safety systems provide a means of control during flight to prevent a launch vehicle and any component, including any payload, from reaching any populated or other protected area in the event of a launch vehicle failure. A flight safety system includes the hardware and software used to protect the public in the event of a launch vehicle failure and the functions of any flight safety system crew.

Failure at the Launch Platform Scenario

A failure at the LP would likely result in a cascading explosion of all ILV propellants. The explosions would scatter pieces of the ILV, and perhaps pieces of the LP, as far as three km (two mi) away (the LP is designed to survive an explosion of the fully fueled launch vehicle). A smoke plume would rise and drift downwind some distance before dissipating. In the course of about one minute, the entire matter and energy of the ILV would be dispersed on the LP and in the environment in a relatively concentrated area of the ocean. Potential environmental effects would include intense heat generated at the ocean surface; debris and noise released during the explosion; emissions released to the atmosphere; and the subsequent cleanup needed on the LP. Despite this intense, short-term, and localized disruption, there would be no discernible long-term impact to the environment.

Launch Abort Scenarios

There is also the potential for a launch abort at the LP (i.e., when a countdown is interrupted or no launch occurs, which is technically not a failure). In general, a launch would be aborted if equipment malfunctions or unresolved deviations of ILV parameters occur just before launch. Due to the inherent complexity of the ILV, a deviation in any number of factors could trigger an abort, and the extent to which propellants need to be safeguarded would vary based on the time prior to launch that the abort occurs. In all cases, however, the resulting contingency measures initiated by SLLP would follow established routines to stabilize the ILV on the LP. A worst-case abort, which would occur within three seconds prior to launch, involves the largest quantities of propellant and the most detailed contingency measures. An abort scenario would involve draining small quantities of propellant into the flame bucket where it would evaporate due to wind effects. In addition, the pyrophoric fluid that initiates kerosene ignition would be burned according to SLLP's operating procedures. The ILV would be returned to a horizontal position in the LP hanger, and the propellant reservoirs from the Stage I engine would be drained into containers for later disposal at the Home Port as a hazardous waste.

Failure During Stage I and II Flight Over Open Ocean Scenario

Failure during Stage I and II flight could occur in two ways: explosive failures or thrust termination failures. The mass and character of hazardous material (including the various propellants) and debris that would reach the ocean would depend on the type and time of failure during a launch (i.e., the longer the flight before failure, the less propellant would be onboard the ILV and available to potentially reach the ocean surface). An ILV failure within the first 20 seconds of flight where the stages fall intact and rupture on the surface is the worst case scenario. A failure at this stage of flight would put all unexpended propellants, other hazardous materials, and ILV hardware into the environment in a more concentrated area than would occur during a successful flight. In general, debris from a failure during Stage I and II flight would fall into the deep waters of the open ocean far from Oceanic Islands.
The primary effects of a failure during flight are:

- Release of emissions to the atmosphere.
- Release of propellants and other hazardous material to the ocean.
- Risk of Stage I or II debris falling on marine organisms, marine vessels, or aircraft.

Explosive versus Thrust Termination Failures

Explosive failures (marked by the sudden destruction of propellants and the ILV during flight) would result in the scattering of ILV parts and the immediate consumption of most if not all of the hazardous materials incorporated by or contained in those parts. In contrast, thrust termination failures (i.e., one in which a deviation in flight triggers engine cutoff) would result in the ILV losing upward and forward momentum and falling toward Earth. In this case, an ILV early in Stage I flight would likely fall intact and rupture on the ocean surface, while later in Stage I flight and during all of Stage II flight, the ILV would begin to tumble within seconds and break up due to stresses on the structure. Explosions may also occur during thrust termination if, as the ILV breaks up, flammable materials become exposed to hot engine parts and ignite. If an explosion does not occur, the extent to which ILV materials would reach the Earth's surface would depend on the altitude and speed of the ILV at the time of thrust termination.

Failure During Upper Stage Flight Over the Ocean, Oceanic Islands, or South America Scenario

Possible failure during flight of the Upper Stage could conceivably occur at any point as the Upper Stage progressively transits over the open ocean, the Oceanic Islands, and the northern part of South America. Given the speed and altitude of the Upper Stage during this period, a failure during any point would result in most of the material components and all of the propellants being heated in the atmosphere and vaporized or burned from frictional effects before reaching the Earth's surface. Approximately 42 components from the Upper Stage and payload would survive reentry friction and reach the Earth's surface. These objects range from 0.04 m (0.13 ft) to 1.2 m (3.9 ft) in size, and 0.3 kg (0.7 lbs) to 90 kg (205 lbs) in mass. The actual amount of debris that survives would depend on the time of failure during the flight (i.e., more debris would survive a failure that occurs earlier during the flight).

An Upper Stage failure has the potential to affect the open ocean, with the impacts being similar to those described above for Stage I and Stage II failures, except that most of the material components and all of the propellant in both the Upper Stage and payload would likely vaporize or burn. Only inert materials, such as durable metals in engine components and batteries, are expected to reach the Earth's surface.

In the unlikely event of an Upper Stage failure, the potential impacts would be small but could occur from debris impacting marine organisms, corral reef communities, terrestrial communities on Oceanic Islands, Central or South American habitats, and vessels, aircraft, or humans. Table ES-3 summarizes the possible types of failures and their consequences under several different failed mission scenarios.

ES.6.2 ALTERNATIVE WITH AVOIDANCE OF OCEANIC ISLANDS

Under this alternative, only azimuths between 82.6^o to 83.28^o, 84.50^o to 85.07^o, 86.36^o to 88.80^o and 92.89^o to 97.40^o would be used. The environmental impacts would be the same as for the license applicant's proposed action except for the impacts to Oceanic Islands and the corresponding portions of South America which would not be overflown in this alternative action.

Upper Stage and payload flight would progressively transit over open ocean waters and the northern part of South America. Upper Stage flight during a successful mission would have no effect on the ocean or land environments or the lower atmosphere because its operation occurs at very high altitudes. The impacts of failure during Upper Stage flight for this alternative would be the same as those for the license applicant's proposed action with the exception that no Stage I or II impact would occur on or near the Oceanic Islands.

ES.6.3 ALTERNATIVE WITH AVOIDANCE OF THE GALAPAGOS ISLANDS

Under this alternative, only azimuths between 83.60^o to 86.80^o and 92.89^o to 97.40^o would be used. The environmental impacts would be the same as for the license applicant's proposed action except for the impacts to the Galapagos Islands and the corresponding portions of South America which would not be overflown in this alternative action.

Upper Stage and payload flight would progressively transit over open ocean waters, the Oceanic Islands (excluding the Galapagos Islands), and the northern part of South America. Upper Stage flight during a successful mission would have no effect on the ocean or land environments of the lower atmosphere because its operation occurs at very high altitudes. The impacts of failure during Upper Stage flight for this alternative would be the same as those for the license applicant's proposed action with the exception that no impact would occur on or near the Galapagos Islands.

ES.6.4 NO ACTION

Under the No Action alternative FAA would not issue an LOL or launch-specific license for Galaxy IIIC to SLLP. SLLP would continue to prepare and submit launch-specific applications for individual licenses to launch up to six satellites per year within the launch parameters addressed in the February 11, 1999 EA. Home Port operations would continue at their present level. If a customer requires a different launch azimuth, SLLP would prepare individual environmental analyses and documentation to support launch-specific applications and submit the documentation to the FAA for review.

TABLE ES-3. SUMMARY OF FAILURE SCENARIOS AND ASSOCIATED ENVIRONMENTAL IMPACTS

Failure Scenarios	Impact Area	Failure Rate	Environmental Impact
During initial Stage I Flight	Launch region	3 x 10^{-18}/seconds (sec)	• ILV impacts open ocean virtually intact (Thrust Termination Failure), or in pieces (Explosive Failure) • Maximum quantity of propellants (e.g., kerosene) released and dispersed in the topmost ocean layer • Inert ILV fragments settle on ocean floor • Very low probability of debris fa lling on vessels (fishing, shipping, or air traffic) as well as marine organisms
During Stage I Flight	Downrange area of 800 km (500 mi)	26.94x 10^{-5}/sec	• ILV (less most Stage I propellants) impacts open ocean after tumbling and fragmentation or explosion • Propellants (e.g., kerosene) released and dispersed in atmosphere through evaporation, residual reaching the topmost ocean layer (or combustion if Explosive Failure) • Inert ILV fragments settle on ocean floor • Very low probability of debris falling on vessels (fishing, shipping, or air traffic) as well as marine organisms
During Stage II Flight	Downrange area beyond 4,600 km (2,900 mi)	28.65x 10^{-5}/sec	• Fragments of the ILV (less Stage I) surviving descent, impact open ocean • Propellants (e.g., kerosene) released and dispersed in atmosphere through evaporation, no propellant expected to reach the topmost ocean layer • Inert ILV fragments settle on ocean floor • Very low probability of debris falling on vessels (fishing, shipping, or air traffic) as well as marine organisms
During Upper Stage Flight Over Ocean Waters	Downrange area beyond 4,600 km (2,900 mi) affecting shipping	6.28 x 10^{-5}/sec	• Fragments of the Upper Stage (ILV less Stages I and II) surviving descent, impact open ocean • Propellants (e.g., kerosene) released and dispersed in atmosphere through evaporation, no propellant expected to reach the topmost ocean layer • Inert ILV fragments settle on ocean floor • Low probability of debris falling on vessels (fishing, shipping, or air traffic) or marine organisms
During Upper Stage Fight Over an Oceanic Island	Potentially populated areas	6.28 x 10^{-5}/sec	• Fragments of the Upper Stage surviving descent, impact terrestrial ecosystems or shallow, near-island ocean • Propellants (e.g., kerosene) released and dispersed in atmosphere through evaporation, no propellant expected to reach the ocean or land • Low probability of debris falling on vessels (fishing, shipping or air traffic) as well as on land or marine organisms
During Upper Stage Flight in vicinity of Panama Canal shipping	Western approaches to Panama Canal affecting shipping	6.28 x 10^{-5}/sec	• Fragments of the Upper Stage surviving descent, impact terrestrial ecosystems or coastal area • Propellants (e.g., kerosene) released and dispersed in atmosphere through evaporation, no propellant expected to reach the ocean or land • Low probability of debris falling on vessels (shipping) or land or marine organisms
During Upper Stage Flight Over South America	Potentially populated areas	6.28 x 10^{-5} /sec	• Fragments of the Upper Stage surviving descent, impact terrestrial ecosystems • Propellants (e.g., kerosene) released and dispersed in atmosphere through evaporation, no propellant expected to reach land • Low probability of debris falling on land organisms, including people

The launch-specific application and license process would be repeated approximately every 60 days, as warranted by commercial demand, requiring more processing time which could affect SLLP's launch schedule. SLLP's launch capacity could be underutilized, and it might be partially constrained in meeting the needs of its customers.

ES.7 CUMULATIVE IMPACTS

Cumulative impacts to the environment result from incremental effects of the license applicant's proposed action combined with other past, present, and reasonably foreseeable actions in the area. This EA focuses on the cumulative impacts associated with eight SLLP launches per year for five years, or a maximum of 40 proposed launches, over the broader range of azimuths of the license applicant's proposed action. Given the isolated location of the *launch site*, there is a lack of *other* past, present or reasonably foreseeable actions in the area that might, in combination with SLLP's actions, cumulatively impact the open ocean environment.

In general, the effects of the license applicant's proposed action would occur on a regional scale. No larger global impacts are expected to occur, mainly because of the small amounts of debris, hazardous material, and atmospheric emissions produced by the ILV relative to the scale of natural processes in the Pacific Ocean and anthropogenic activities (e.g., power generation) worldwide.

The cumulative effects for each phase of the launch operation are discussed below.

ES.7.1 HOME PORT

Other than the increase in the number of launches requiring processing, operations at the Home Port would be the same as those evaluated in the February 11, 1999 EA. The higher rate of throughput of both payload processing and marine vessel activity would remain within the capacity and regulatory approvals of all Home Port facilities, which were designed by SLLP to handle eight launches per year. Using unsymmetrical dimethylhydrazine (UDMH) in the Upper Stage would not create a new impact resulting from Home Port operations as SLLP will modify and comply with all Federal, state, and local permit requirements. In addition, scrubbers specifically designed to capture UDMH vapors have been installed at the Home Port facilities.

ES.7.2 PRE-LAUNCH

Transit of the LP and ACS from Home Port to the launch site would be like any normal maritime shipping and would be subject to U.S., United Nations (UN), and other international rules and regulations. The two additional round-trip transits by the ACS and LP per year would not contribute significantly to marine vessel traffic on the Pacific Ocean.

The pre-launch operations would be the same as those evaluated in the February 11, 1999 EA. No cumulative effects are expected from pre-launch operations.

ES.7.3 LAUNCH

Repeated launches over the Pacific Ocean present the potential for cumulative impacts, which may be one of two types:

- Effects of debris blown into the ocean, and
- Effects of heat and noise on marine mammals.

ES.7.3.1 Potential Effects of Debris Blown into the Ocean

The launch may blow some scattered debris into the ocean, although experience from launches to date has shown that little to no material has been lost. The increase in the number of flights would possibly result in more debris entering the ocean environment; however, the volume of material remains very small relative to the scale of the east central Pacific Ocean.

ES.7.3.2 Potential Effects of Heat and Noise on Marine Mammals

The energy from heat and sound at launch would have only a momentary impact on the ocean, and would be dissipated within minutes, leaving no lasting or cumulative impact. Environmental monitoring activities have occurred immediately before and after each launch. No impacts to the local marine environment have been observed during the monitoring efforts.

ES.7.4 SUCCESSFUL FLIGHT OVER THE OPEN OCEAN, OCEANIC ISLANDS, AND SOUTH AMERICA

It should be noted that although the license applicant's proposed action includes launches on a range of azimuths from 82.6º to 97.4º, actual flights would likely be along a more narrow band of azimuths, likely focused around 90º. Accordingly, cumulative impacts from successful missions over the five years of the license applicant's proposed action would be expected along a more concentrated area of the open ocean (i.e., into smaller spent stage deposition areas).

ES.7.4.1 Spent Stages and Fairing Debris, including Hazardous Materials

Of all the impacts listed above for successful launches, the stage and fairing debris would be the only launch byproduct that would remain in the environment for a long period of time. Stage I would be expected to occasionally break up upon descent, while Stage II is expected to always break up during its descent from a high altitude. For both stages, the debris would fall into the open ocean environment where surviving objects would cool and sink almost immediately upon reaching the water surface with the exception of the fairing pieces.

From a cumulative impact perspective, the amount of debris is negligible when compared to the expanse of the equatorial Pacific Ocean. To evaluate cumulative impacts, a worst case scenario would be that all 40 launches would use the same azimuth. This hypothetical scenario further assumes that the deposited stage and fairing debris do not overlap (i.e., the flattened stage debris sinks to the bottom of the ocean without overlapping with previously deposited stage debris), only 0.00015 percent of the ocean floor in the impact zones would be affected by the 40 launches. Even with this hypothetical worst case scenario, the resulting impact to the regional seafloor would be insignificant.

ES.7.4.2 Residual Propellants Released from the Spent Stages to the Ocean and Atmosphere

During each launch, the kerosene would evaporate and degrade relatively quickly. Specifically, almost 95 percent of any kerosene released from spent stages would evaporate and be dispersed as smog by reacting with solar energy and dissipated into the environment through natural processes. The remaining kerosene on the ocean surface would be dispersed by turbulence in the top few meters of the ocean, and be degraded to carbon dioxide (CO_2) and water (H_2O) through photochemical oxidation and microbial degradation within days of the initial release (Doerffer, 1992; National Research Council, 1985; Rubin, 1989; ITOPF, 2001; and EPA, 1999).

LOX released to the environment as the spent stages break up during descent or on the ocean surface would instantaneously vaporize upon being exposed to ambient pressure and temperature. Accordingly, the ocean environment would essentially return to pre-launch conditions within a few days and long before the next launch would occur (45 days later under the license applicant's proposed action).

ES.7.4.3 Emissions to the Atmosphere

The proposed launches would affect the atmosphere due to the combustion of propellants, with the associated generation of gas, vapor, and particulate matter emissions, and the physical passage of the ILV through the atmosphere. Total annual and cumulative (i.e., from 40 launches) emissions by altitude are provided in Table ES-4.

TABLE ES-4. TOTAL ANNUAL AND CUMULATIVE EMISSIONS FOR EIGHT LAUNCHES A YEAR

Atmospheric Layer	Altitude* Range (km (mi))	Annual Propellant Consumed (kg (lbs))	Annual Emission Products Assuming Eight Launches in kg (lbs)				
			CO**	CO_2	H_2	H_2O	N_2
Lower Troposphere	0.0-2.0 (0.0-1.2)	493,712 (1,086,166)	136,264 (299,781)	215,256 (473,563)	3,456 (7,603)	138,736 (305,219)	0
Free Troposphere	2.0-10.0 (1.2-6.2)	552,800 (1,216,160)	152,576 (336,667)	241,024 (530,253)	3,872 (8,518)	155,336 (341,739)	0
Stratosphere	10.0-51.0 (6.2-32)	1,270,648 (2,795,425)	350,696 (771,531)	554,000 (1,218,800)	8,896 (19,571)	357,056 (785,523)	0
Mesosphere and Thermosphere	51.0-292 (32-182)	997,576 (2,150,667)	271,896 (598,171)	444,064 (976,940)	7,928 (17,442)	273,808 (602378)	290 (640)
	Annual (8 Launches) Total	3,314,736 (7,248,418)	911,432 (2,009,156)	1,454,344 (3,199,110)	24,152 (53,134)	924,936 (2,034,859)	290 (640)
	Cumulative 5-Year (40 Launches) Total	16,573,680 (36,242,090)	4,557,160 (10,045,780)	7,271,720 (15,995,550)	120,760 (265,670)	4,624,680 (10,174,295)	1,450 (3,200)

* Altitude ranges are rounded to the nearest km.

** Carbon monoxide (CO), carbon dioxide (CO_2), hydrogen (H_2), water (H_2O), nitrogen (N_2)

Global warming and ozone depletion could be cumulative effects of the license applicant's proposed action. However, the contribution of these emissions is negligible when compared to other global sources, natural or man-made. The greatest risk for adverse atmospheric impacts due to ILV emissions would be in the area of ozone layer destruction. The ILV does not release chlorine or chlorine compounds (which contribute to ozone destruction) in or below the stratosphere, and the SLLP impact in this regard would not be significant.

ES.7.5 POST-LAUNCH

After a successful launch, the crew would reoccupy and clean the LP in preparation for transit to the Home Port. Any debris would be collected and handled onboard as solid waste for later disposal at Home Port. The amount of solid waste is insignificant and would not present any adverse cumulative effects as part of the overall waste stream managed while at sea and properly disposed of when the vessels return to the Home Port.

ES.7.6 MULTIPLE LAUNCH FAILURES IN A SINGLE YEAR IN THE SAME AREA

From a cumulative impact perspective, the most significant adverse environmental effect associated with the license applicant's proposed action would be the failure of multiple launches in a single year along the same azimuth in close proximity to one another. In considering a scenario that would result in a worst-case cumulative impact, two consecutive failures that affect the same geographic area are evaluated. Considering several (i.e., more than two) consecutive mission failures, however, is not practical since such a circumstance would challenge the continued viability of the SLLP launch concept.

ES.7.6.1 Time Period Between Launches Following a Failure for An Investigation

Considering multiple, successive failures as a hypothetical worst case, and given the mandatory investigation process, the two successive failures would occur many months apart. For both safety and commercial reasons, launches would not be resumed until the cause of the failure is determined and corrected to the satisfaction of the FAA and SLLP.

ES.7.6.2 Failure Scenarios Affecting the Ocean

Even under the worst-case scenario where the entire amount of propellants and other hazardous materials on the ILV are released directly to the ocean, the ocean environment would recover to natural conditions within a week. The subsequent launch, allowing for the amount of time required for mandatory investigation, would not occur until four to 12 months later. Therefore, no cumulative impact would occur as a result of successive, worst-case failures, even those that happen to affect the same area of the ocean because the amount of time between possible launch failures would allow the ocean environment time to fully recover.

ES.7.6.3 Failure Scenarios Affecting the Oceanic Islands or Central or South American Landmasses

The Oceanic Islands and Central or South America could only be affected by a failure during Upper Stage flight (any failures earlier in flight would only affect the ocean environment). An Upper Stage failure could be the result of either thrust termination or explosion. Both of these types of failures would have the same environmental effects and therefore are collectively considered the worst-case scenario in terms of Oceanic Islands or Central or South American effects.

A possible failure during Upper Stage flight would result in most of the ILV components and all of the propellants and other hazardous materials being heated in the atmosphere and vaporized or burned from frictional effects before reaching the Earth's surface due to the speed and altitude of the Upper Stage at this point in flight. The only potential adverse effects from the components would be the physical damage associated with striking individual terrestrial plant or animal species.

If debris struck an animal, it could be injured or killed. There is an extremely remote chance that an individual of a threatened or endangered species could be hit by falling debris. Should such harm occur, an individual's replacement in terms of population dynamics would depend on the individual species' abundance, reproduction characteristics, and recruitment success.

These additional cumulative impacts would likely be minor, with the exception of any endangered species that may be hit. The probability of these components falling on the Galapagos Islands, for example, is very low (i.e., 0.00067), and the probability of striking an endangered species would be even more remote.

ES.8 ENVIRONMENTAL MONITORING AND PROTECTION PLAN (EMPP)

The EMPP is an evolving document of mitigation measures, incorporating improvements identified by the FAA, SLLP, or suggested by the public. The plan consists of four elements:

- Visual observation for species of concern.
- Remote detection of atmospheric effects during launch.
- Collection of surface water samples to detect possible launch effects.
- Notification to mariners and air traffic.